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(54) **VEHICLE DOOR ASSISTANCE**

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E05B 77/12	(2014.01)
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E05F 15/72	(2015.01)
E05B 81/76	(2014.01)
E05F 15/611	(2015.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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USPC 49/31

See application file for complete search history.

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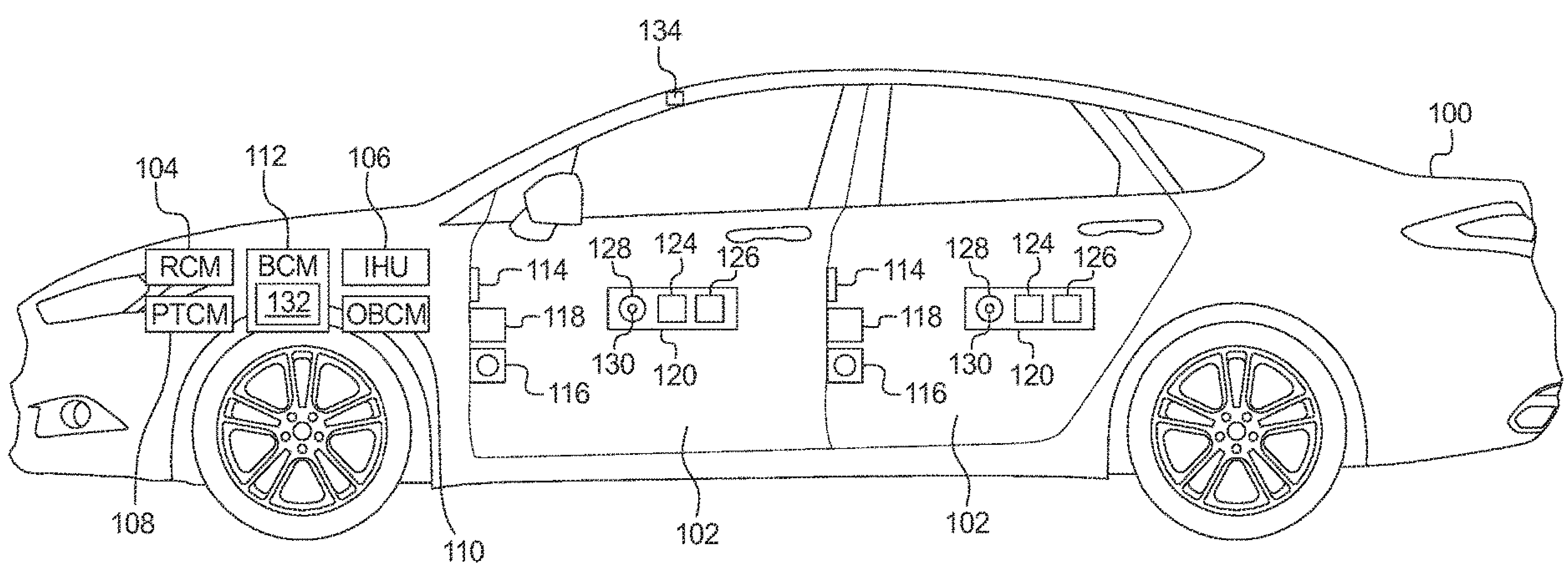
(57) **ABSTRACT**

Method and apparatus are disclosed for vehicle door assistance. An example vehicle includes a solenoid between a frame of the vehicle and a door, a restraint control module with an accelerometer to provide a roll angle and a pitch angle of the vehicle; and a body control unit. The body control unit determines a door adjustment force based on the roll and pitch angles and personal characteristics of an occupant, and when a door is moving, applies the door adjustment force with the solenoid.

13 Claims, 6 Drawing Sheets



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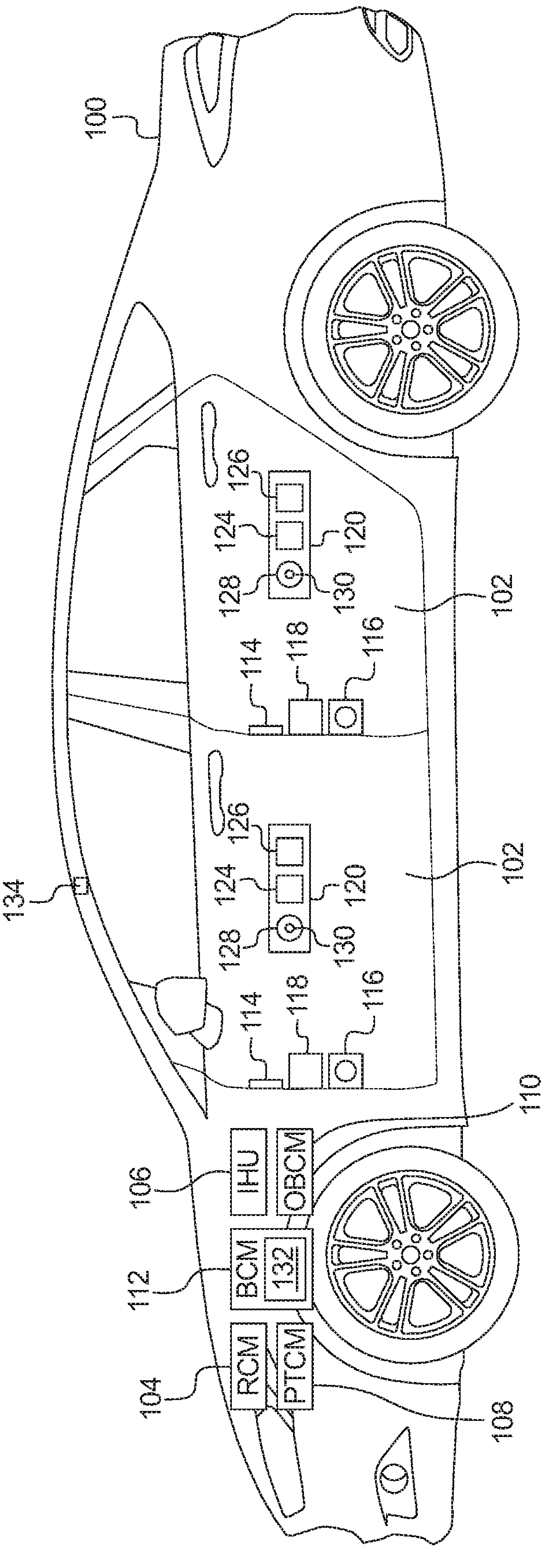
100
102
102
104
106
108
110
112
114
114
116
116
118
118
120
120
124
124
126
126
128
128
130
130
132
134
RCM
BCM
IHU
PTCM
OBCM

FIG. 1

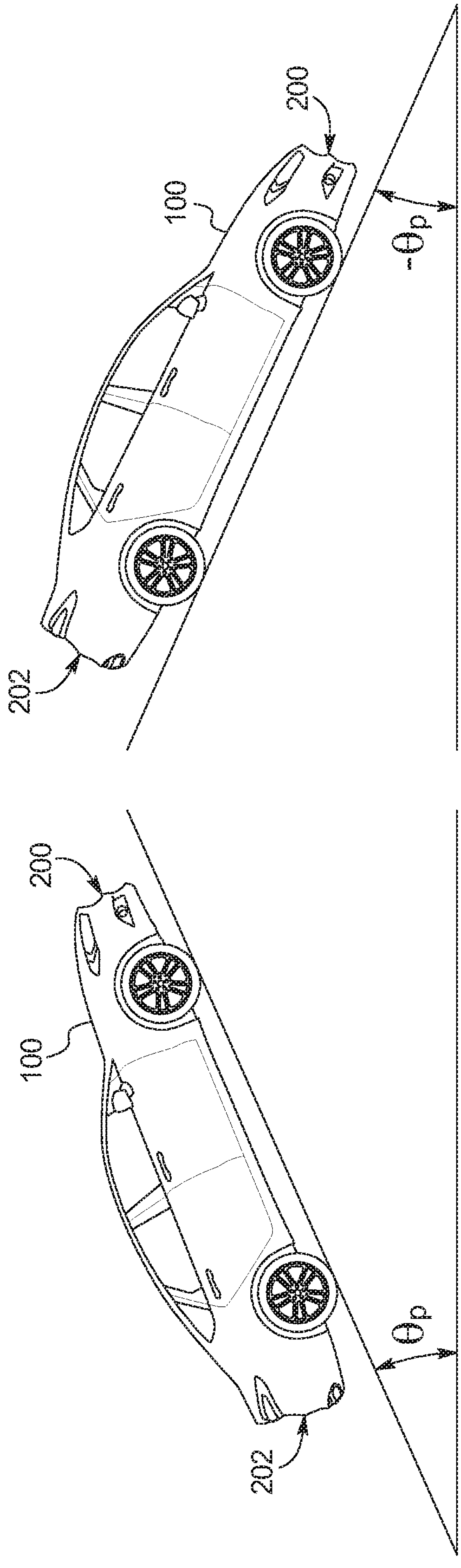

FIG. 2A

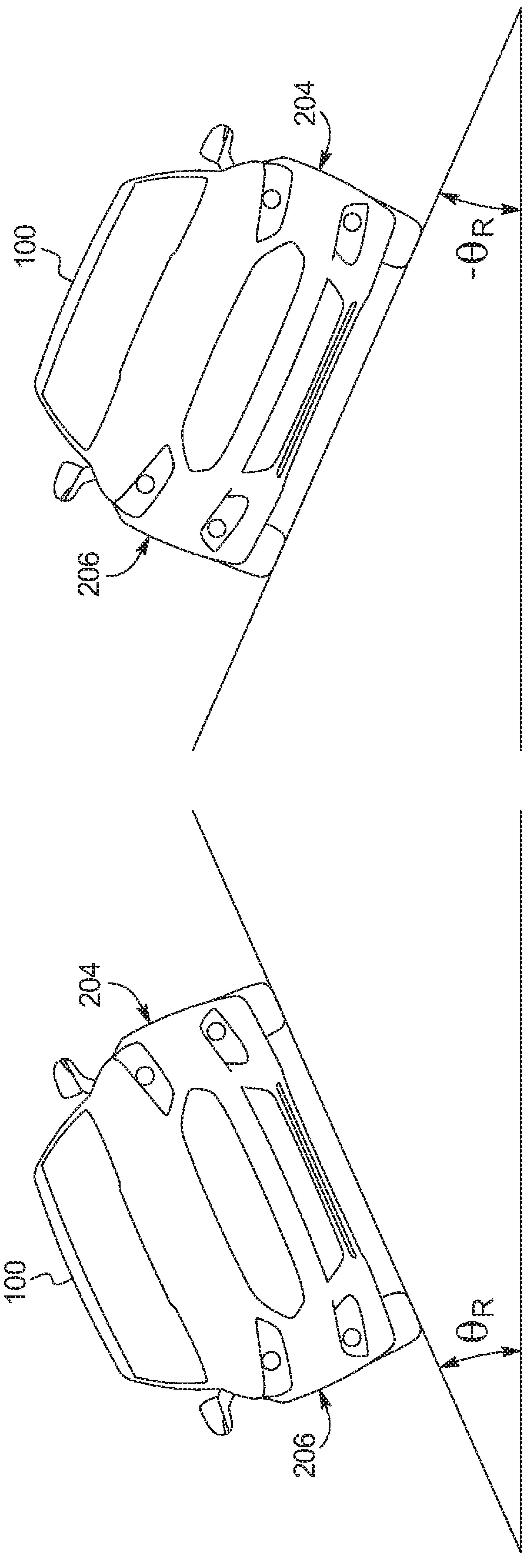

FIG. 2B

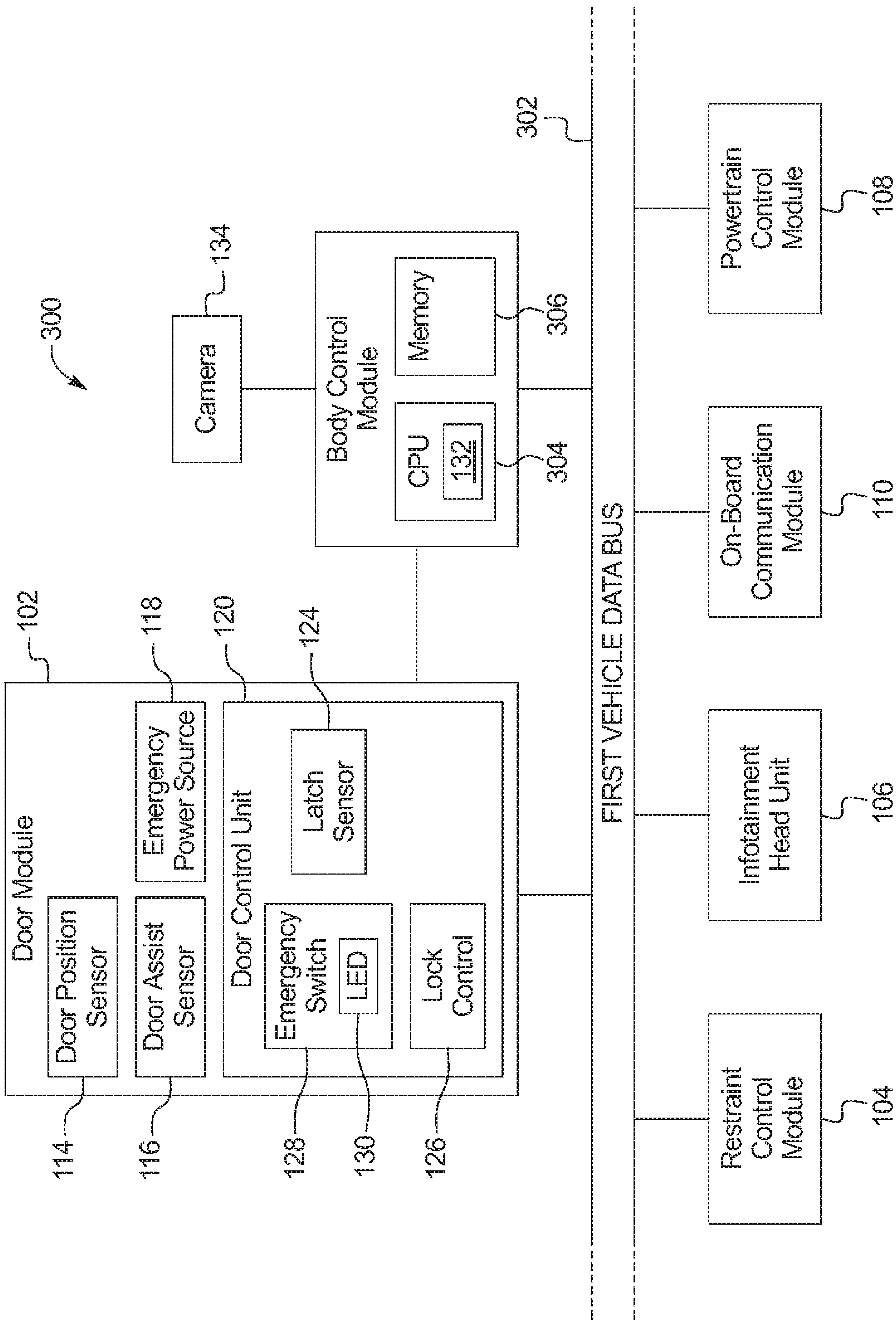
300
Door Module
102
Door Position Sensor
114
Door Assist Sensor
116
Emergency Power Source
118
Door Control Unit
120
Latch Sensor
124
Emergency Switch
128
LED
130
Lock Control
126
Camera
134
Body Control Module
CPU
132
304
Memory
306
302
FIRST VEHICLE DATA BUS
Powertrain Control Module
108
On-Board Communication Module
110
Infotainment Head Unit
106
Restraint Control Module
104

FIG. 3

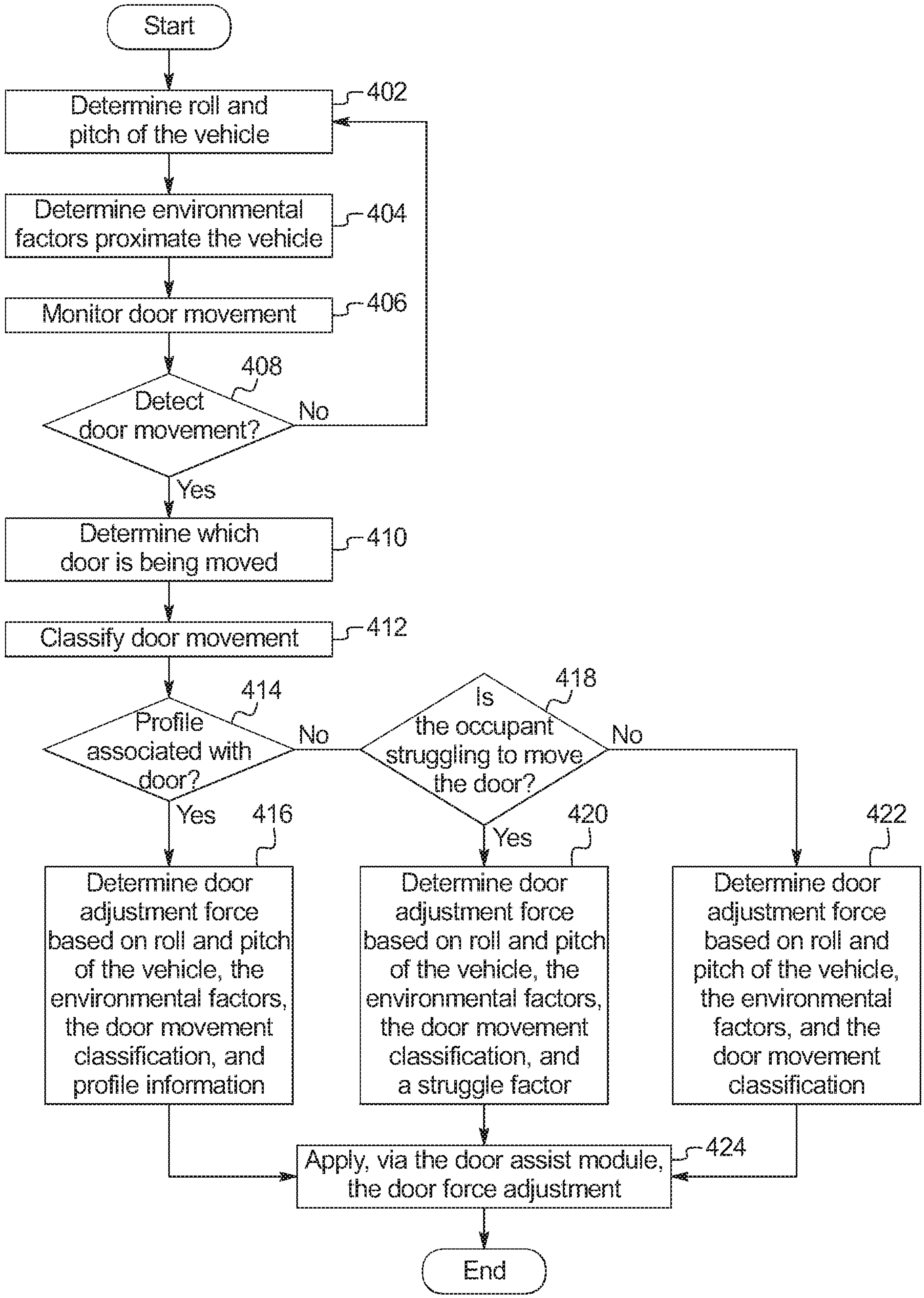
Start
Determine roll and pitch of the vehicle
402
Determine environmental factors proximate the vehicle
404
Monitor door movement
406
408
Detect door movement?
No
Yes
Determine which door is being moved
410
Classify door movement
412
414
Profile associated with door?
No
Yes
416
418
Is the occupant struggling to move the door?
No
Yes
420
422
Determine door adjustment force based on roll and pitch of the vehicle, the environmental factors, the door movement classification, and profile information
Determine door adjustment force based on roll and pitch of the vehicle, the environmental factors, the door movement classification, and a struggle factor
Determine door adjustment force based on roll and pitch of the vehicle, the environmental factors, and the door movement classification
Apply, via the door assist module, the door force adjustment
424
End

FIG. 4

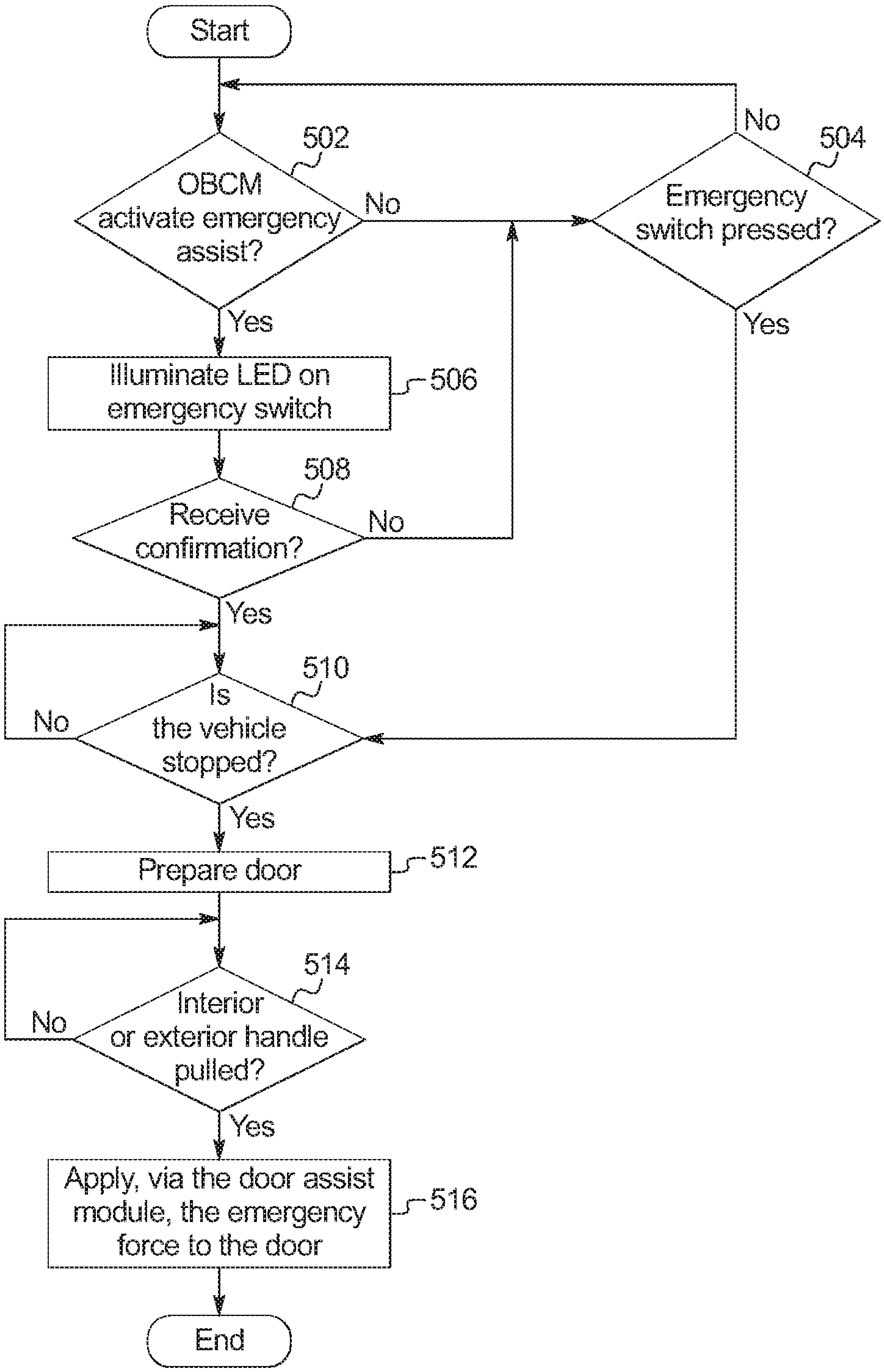
Start
OBCM activate emergency assist?
502
No
Yes
Emergency switch pressed?
504
No
Yes
Illuminate LED on emergency switch
506
Receive confirmation?
508
No
Yes
Is the vehicle stopped?
510
No
Yes
Prepare door
512
Interior or exterior handle pulled?
514
No
Yes
Apply, via the door assist module, the emergency force to the door
516
End

FIG. 5

VEHICLE DOOR ASSISTANCE

TECHNICAL FIELD

The present disclosure generally relates to doors of vehicles and, more specifically, vehicle door assistance.

BACKGROUND

The muscle load and body kinematics required to open and close doors of a vehicle can vary based on various vehicle parameters and environmental factors. Often, the doors are hard to open and close, which can be difficult for drivers and passengers with reduce mobility and reduce strength.

SUMMARY

The appended claims define this application. The present disclosure summarizes aspects of the embodiments and should not be used to limit the claims. Other implementations are contemplated in accordance with the techniques described herein, as will be apparent to one having ordinary skill in the art upon examination of the following drawings and detailed description, and these implementations are intended to be within the scope of this application.

Example embodiments are disclosed for vehicle door assistance. An example vehicle includes a solenoid between a frame of the vehicle and a door, a restraint control module with an accelerometer to provide a roll angle and a pitch angle of the vehicle; and a body control unit. The body control unit determines a door adjustment force based on the roll and pitch angles and personal characteristics of an occupant, and when a door is moving, applies the door adjustment force with the solenoid.

An example method includes determining, via an restrain control module, a pitch angle and a roll angle of a vehicle. The example method also includes determining personal characteristics of an occupant based on a profile associated with a door and determining a door adjustment force based on the roll and pitch angles, a motion of the door relative to the roll and pitch angles, and personal characteristics of an occupant. Additionally, the example method includes, when the door is in motion, applying the door adjustment force with a solenoid positioned between a frame of the door and a frame of the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, reference may be made to embodiments shown in the following drawings. The components in the drawings are not necessarily to scale and related elements may be omitted, or in some instances proportions may have been exaggerated, so as to emphasize and clearly illustrate the novel features described herein. In addition, system components can be variously arranged, as known in the art. Further, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** illustrates a vehicle operating in accordance with the teachings of this disclosure.

FIG. **2**A illustrates the vehicle of FIG. **1** parked on a roadway with a pitch angle.

FIG. **2**B illustrated the vehicle of FIG. **1** parked on the roadway with a roll angle.

FIG. **3** depicts a block diagram of the electronic components of the vehicle of FIG. **1**.

FIG. **4** is a flowchart of a method to apply a door adjustment force to a door of the vehicle of FIG. **1**, which may be implemented by the electronic components of FIG. **3**.

FIG. **5** is a flowchart of a method to apply an emergency force to the door of the vehicle of FIG. **1**, which may be implemented by the electronic components of FIG. **3**.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

While the invention may be embodied in various forms, there are shown in the drawings, and will hereinafter be described, some exemplary and non-limiting embodiments, with the understanding that the present disclosure is to be considered an exemplification of the invention and is not intended to limit the invention to the specific embodiments illustrated.

The muscle load and body kinematics required to open and close doors of a vehicle can vary based on various vehicle parameters, such as door mass, hinge locations, friction, hand position with respect to the door, magnitude and directions of external forces. Additionally, the muscle load and body kinematics required to open and close doors of a vehicle can vary based on the surface that the vehicle is parked on. The surface may have a pitch angle and/or a roll angle. The pitch angle is an angle relative to a flat surface of the vehicle about its lateral axis. The pitch angle is positive when the front of the vehicle is elevated relative to the rear of the vehicle, and negative when the rear of the vehicle is elevated relative to the front of the vehicle. The roll angle is an angle relative to a flat surface of the vehicle about its longitudinal axis. The roll angle is positive when the passenger side (e.g., the right side) of the vehicle is elevated relative to the driver side (e.g., the left side) of the vehicle, and negative when the driver side of the vehicle is elevated relative to the passenger side of the vehicle. For example, when the vehicle is parked on an incline such that the roll angle is negative, opening the driver side doors requires more force than when the vehicle is parked on a flat surface.

As disclosed below, a vehicle includes system to apply a force to doors of the vehicle to assist an occupant opening and closing the doors and/or apply a force to the door in case of an emergency. The system determines the roll angle and pitch angle of the vehicle, the environmental factors (e.g., wind, temperature, etc.) around the vehicle, and/or the direction of the door movement (e.g., opening or closing). In some examples, the system also determines characteristics (e.g., age, strength, ability, etc.) of the occupant handling the door based on a profile and/or settings. Additionally, in some examples, the system determines whether the occupant is struggling with the door (e.g., the door is opening slowly, the door is closing quickly, etc.). Based on these determinations, the system determines an adjustment force to apply to the door with a door assist module (e.g., a hydraulic solenoid, a spring force solenoid, etc.) to assist the occupant with opening or closing the door.

Additionally, in some examples, the system determines when an emergency, such as an accident, has occurred. For example, the system may monitor for the on-board communication module activates emergency assist and/or an occupant pushes an emergency switch embedded in the door. In some examples, the emergency mode may be activated by a transponder controlled by emergency personnel (e.g., a police officer, a fire fighter, an EMT, etc.). When the emergency mode is activated and the exterior or interior door handle is pulled, the door assist module applied an emergency force to the door. In some examples, the emergency force is a maximum amount of force the door assist module can produce.

FIG. **1** illustrates a vehicle **100** operating in accordance with the teachings of this disclosure. The vehicle **100** may be a standard gasoline powered vehicle, a hybrid vehicle, an electric vehicle, a fuel cell vehicle, and/or any other mobility implement type of vehicle. The vehicle **100** includes parts related to mobility, such as a powertrain with an engine, a transmission, a suspension, a driveshaft, and/or wheels, etc. The vehicle **100** may be non-autonomous, semi-autonomous (e.g., some routine motive functions controlled by the vehicle **100**), or autonomous (e.g., motive functions are controlled by the vehicle **100** without direct driver input). In the illustrated example the vehicle **100** includes door modules **102**, a restraint control module (RCM) **104**, an infotainment head unit (IHU) **106**, a power train control module (PTCM) **108**, an on-board communication module (OBCM) **110**, and a body control module (BCM) **112**.

The door modules **102** include components embedded into a door and/or a frame of the vehicle **100**. In the illustrated example, the door modules include a door position sensor **114**, a door assist module **116**, an emergency power source **118**, and a door control unit **120**. The door position sensor **114** provides information about the state of the corresponding door. The information includes the position of the door (e.g., open or closed), the angle of the door (e.g., between opened and closed), the speed of the door being opened/closed, and/or a direction of movement of the door (e.g., between opened and closed), etc.

The door assist module **116** is hardware that includes a device to apply force to the door to deduce the force necessary for an occupant to open or close the door safely (e.g., by reducing the force of the door when it is closing to counteract the gravitational force, etc.). The door assist module **116** also includes control circuitry. The device is positioned to interact with the door and the frame of the vehicle on the hinge side **122** of the door. In some examples, the device is a solenoid. In such examples, the device may be a hydraulic solenoid or a variable-force solenoid. The door assist module **116** is communicatively coupled to the body control module **112**. The door assist module **116** receives commands from the body control module **112**. The commands include the force to be applied to the door and/or entering an emergency mode. The command may include the force to be applied to the door in a raw force value (e.g., a value in Newtons (N), etc.) or in a percentage (e.g., 50% of the solenoid's maximum force, etc.), etc.

The emergency power source **118** is an energy storage device (e.g., a battery, a high current capacitor, etc.) that is capable of energizing the door assist module **116** in the event that the power bus of the vehicle **100** is no longer supplying power. In some examples, the emergency power source **118** is capable of supplying power to the door assist module **116** for the door assist module to supply an emergency force to the door.

The door control unit **120** includes circuitry to receive commands from the body control module **112** and control operations relating to the door, such as a power window and a power latch. In the illustrated example, the door control unit **120** includes a handle sensor **124**, a lock control **126**, and a emergency switch **128**. The handle sensor **124** detects when the internal and/or external handle of the vehicle **100** is activate/pulled. The handle sensor **124** may be a mechanical switch, a capacitive switch, or an infrared sensor, etc. The lock control **126** controls the latch of the door. The emergency switch **128** is a mechanical switch or button that, when activated puts the vehicle **100** into the emergency mode. In some examples, to prevent accidental triggering, the emergency switch **128** is recessed into the door and/or is covered by a movable panel. The emergency switch **128** may also include a cover to prevent the emergency switch **128** from being accidentally activated. In the illustrated example, the emergency switch **128** includes a lighting element **130**, such as a light emitting diode (LED). The LED lights up when, for example, the body control module **112** detects that the vehicle **100** has been involved in an accident.

The restraint control module **104** is an electronic control unit (ECU) that includes an accelerometer and other inertial sensors, such a gyroscope. An electronic control unit is a hardware device that includes circuits, sensors, and/or firmware to provide monitor and/or control functions for a particular set of systems in the vehicle **100**. The restraint control module **104** measures and provides the pitch and roll angles to the body control module **112**. The restraint control module **104** is typically mounted to the floor of the vehicle **100** between the front seats.

FIGS. **2**A and **2**B illustrate pitch angles (θ_P) and roll angles (θ_R). The pitch angle (θ_P) and roll angle (θ_R) affect the magnitude that the gravitational force acts on the doors of the vehicle **100**. In FIG. **2**A, the vehicle **100** is parked longitudinally on an incline. When the front **200** of the vehicle **100** is elevated relative to the rear **202** of the vehicle **100**, the pitch angle (θ_P) is positive. When the rear **202** of the vehicle **100** is elevated relative to the front **200** of the vehicle **100**, the pitch angle (θ_P) is negative. When the pitch angle (θ_P) is positive, additional force is required to open the door to overcome the effects of the gravitational force and less force or a dampening force is required close the door. Similarly, when the pitch angle (θ_P) is negative, additional force is required to close the door to overcome the effects of the gravitational force and less force or a dampening force is required open the door. In FIG. **2**B, the vehicle **100** is parked laterally on a incline. The roll angle (θ_R) is positive when the driver side **204** (e.g., the left side) of the vehicle **100** is elevated relative to the passenger side **206** (e.g., the right side). The roll angle (θ_R) is negative when the passenger side **206** of the vehicle **100** is elevated relative to the driver side **204**. When the roll angle (θ_R) is positive, (i) additional force is required to open doors on the driver side **204**, (ii) less force or a dampening force is required to close the doors on the driver side **204**, (iii) additional force is required to close doors on the passenger side **206**, and (iv) force or a dampening force is required to open the doors on the passenger side **206**. Similarly, when the roll angle (θ_R) is negative, (i) additional force is required to close doors on the driver side **204**, (ii) less force or a dampening force is required to open the doors on the driver side **204**, (iii) additional force is required to open doors on the passenger side **206**, and (iv) force or a dampening force is required to close the doors on the passenger side **206**. In FIG. **2**A, the vehicle **100** is illustrated to have a pitch angle (θ_P) and not a roll angle (θ_R). In FIG. **2**B, the vehicle is illustrated to have a roll angle (θ_R) and not a pitch angle (θ_P). However, when parked, the vehicle **100** may have a combination of a pitch angle (θ_P) and a roll angle (θ_R) depending on the terrain the vehicle **100** is parked on.

Returning to FIG. **1**, the infotainment head unit **106** provides an interface between the vehicle **100** and a user. The infotainment head unit **106** includes digital and/or analog interfaces (e.g., input devices and output devices) to receive input from the user(s) and display information. The input devices may include, for example, a control knob, an instrument panel, a digital camera for image capture and/or visual command recognition, a touch screen, an audio input device (e.g., cabin microphone), buttons, or a touchpad. The output devices may include instrument cluster outputs (e.g., dials, lighting devices), actuators, a heads-up display, a center console display (e.g., a liquid crystal display ("LCD"), an organic light emitting diode ("OLED") display, a flat panel display, a solid state display, etc.), and/or speakers. In some examples, the infotainment head unit **106** includes hardware (e.g., a processor or controller, memory, storage, etc.) and software (e.g., an operating system, etc.) for an infotainment system (such as SYNC® and MyFord Touch® by Ford®, Entune® by Toyota®, IntelliLink® by GMC®, etc.). Additionally, the infotainment head unit **106** displays the infotainment system on, for example, the center console display. The infotainment system may be used to receive preferences and settings from occupants of the vehicle **100**. For example, an occupant may use the infotainment system to identify a profile associated with a particular seat and/or characteristics of the person in a particular seat that effect the force applied to the corresponding door. In such a manner, each door may be associated with different profiles and settings.

The power train control module **108** is an electronic control unit that controls functions of the engine system and the transmission system. The power train control module **108** receives measurements from sensors installed around the vehicle **100** to manage the engine of the vehicle **100**. The power train control module **108** provides the state of the vehicle transmission (e.g., which gear the vehicle **100** is in, etc.) to the body control module **112**.

The on-board communications module **110** includes wired or wireless network interfaces to enable communication with external networks. The on-board communications module **110** also includes hardware (e.g., processors, memory, storage, antenna, etc.) and software to control the wired or wireless network interfaces. In the illustrated example, the on-board communications module **110** includes one or more communication controllers for standards-based networks (e.g., Global System for Mobile Communications (GSM), Universal Mobile Telecommunications System (UMTS), Long Term Evolution (LTE), Code Division Multiple Access (CDMA), WiMAX (IEEE 802.16m); local area wireless network (including IEEE 802.11 a/b/g/n/ac or others), dedicated short range communication (DSRC), and Wireless Gigabit (IEEE 802.11ad), etc.).

In some examples, the on-board communications module **110** includes a wired or wireless interface (e.g., an auxiliary port, a Universal Serial Bus (USB) port, a Bluetooth® wireless node, etc.) to communicatively couple with a mobile device (e.g., a smart phone, a smart watch, a tablet, etc.). In such examples, the vehicle **100** may communicate with the external network via the coupled mobile device. The external network(s) may be a public network, such as the Internet; a private network, such as an intranet; or combinations thereof, and may utilize a variety of networking protocols now available or later developed including, but not limited to, TCP/IP-based networking protocols.

In some examples, the on-board communications module **110** includes an emergency assist system. When the emergency assist system detects that the vehicle has been involved in an accident (e.g., detects that an air bag has been deployed, etc.), the emergency assist system contacts emergency services. Additionally, in some examples, the emergency assist system activates an emergency mode.

The body control module **112** controls various subsystems of the vehicle **100**. For example, the body control module **112** may control power windows, power locks, an immobilizer system, and/or power mirrors, etc. The body control module **112** includes or is communicatively coupled to circuits to, for example, drive relays (e.g., to control wiper fluid, etc.), drive brushed direct current (DC) motors (e.g., to control power seats, power locks, power windows, wipers, etc.), drive stepper motors, and/or drive LEDs, etc. In the illustrated example, the body control module **112** a door assister **132**. The door assister **132** provides a door adjustment force and/or an emergency force to a door via the door assist module **116**. The door adjustment force applies a positive or negative force to assist opening and closing the door. The emergency force applies a positive force to assist opening the door when the vehicle **100** is in an emergency mode.

The door assister **132** calculates the door adjustment force based on (a) the pitch and roll angles of the vehicle **100**, (b) the position of the door being opened/closed relative to the pitch and roll angles of the vehicle **100**, (c) vehicle parameters, such as door mass, hinge locations, friction, hand position with respect to the door, (d) magnitude and directions of external forces (e.g., wind, etc.), and/or (e) physical attributes (e.g., age, health, medical condition, body size, ability, etc.) of the occupant opening a door based on a profile and/or settings entered into the infotainment system. The door assister **132** includes a multi-factor look up table that are generated by simulations and/or empirical testing. Physical or virtual data is analyzed utilizing numerical regression techniques to develop a mathematical polynomial function that provides confidence without complexity. In some examples, the polynomial function that is the basis of the look-up table is based on a design of experiment matrix using full factorial design or fractional factorial design techniques.

In some examples, the door assister **132** receives the physical attributes if the occupant(s) of the vehicle **100** via the infotainment head unit **106**. In some such examples, the infotainment head unit **106** identifies a profile of the occupant(s) (e.g., by recognizing a paired mobile device/key fob, by manual entry, by biometric identification, by facial recognition via a camera **134**, etc.). Additionally or alternatively, in some examples, the infotainment system provides a graphical user interface in which the occupant can select profiles, manually specify physical attributes of the occupants, and/or associate settings with particular doors, etc.

To calculate the door adjustment force, the door assister **132** determines the pitch and roll angle of the vehicle **100** from the restraint control module **104**. The door assister **132** then determines the environmental factors, such as the direction and strength of the wind, proximate the vehicle **100**. The door assister **132** monitors the doors for movement via the door position sensor **114** and/or the handle sensor **124**. When movement is detection, the door assister **132** determines which door is being moved. The door assister **132** classifies the movement of the door based on (a) whether the door is opening or closing and (b) the directions of the gravitational force on the door being moved accounting for (i) the pitch and roll angles of the vehicle **100** and (ii) the relative position of the door to the pitch and roll angles. For example, when the pitch is positive, the gravitational force will cause the door to require less force to open or, depending on the angle, open without any additional force from the occupant. The look-up table provides a factor that specifies a force or setting for the door assist module **116** to apply to the door. The force or setting may specify in a raw force value (e.g., a value in Newtons (N), etc.) or in a percentage (e.g., 50% of a maximum available force of the door assist module **116**, etc.), etc.

When the door is associated with a profile or settings, the door assister **132** determines, via the look-up table, the door adjustment force based on the roll and pitch angles of the vehicle, the environmental factors, the door movement classification, and the physical attributes of the occupant associated with the profile or settings. For example, when (1) the pitch angle is positive, (2) the driver side door is being opened, (3) wind is blowing from the aft of the vehicle **100** to the front of the vehicle **100**, and (4) the profile identifies that the corresponding occupant is small in stature, the door assister **132** may determine a negative door adjustment force to counteract the other forces that may cause the door to open quickly. As another example, when (1) the roll angle is positive, (2) the passenger side door is being opened, and (3) the profile indicates that the corresponding occupant is at least sixty years old, the door assister **132** may determine a positive door adjustment force to assist opening the door.

In some examples, the door assister **132** determines whether the occupant opening or closing the door is struggling. In such examples, when the occupant opening or closing the door is struggling, the door assister **132** adjusts the door adjustment force. For example, if the occupant is struggling to open the door, the door assister **132** may increase the door adjustment force. The door adjustment force. The door assister **132** determines whether the occupant is struggling based on image recognition via the camera **134** and/or motion detected by the door position sensor **114**. For example, jerky movement of the door detected by the door position sensor **114** may indicate that the occupant is struggling. In such examples, when struggling is detected, the door assister **132** increases or decreases the door adjustment force supplied by the door assist module **116** depending on the movement of the door and the pitch and roll angles relative to the door.

When the door assister **132** determines that the door is not associated with a profile or settings and does not detect the occupant struggling, the door assister **132** determines, via the look-up table, the door adjustment force based on the roll and pitch angles of the vehicle, the environmental factors, the door movement classification.

FIG. **3** depicts a block diagram of the electronic components **300** of the vehicle **100** of FIG. **1**. The illustrated example, the electronic components include the door modules **102**, the restraint control module **104**, the infotainment head unit **106**, the power train control module **108**, the on-board communications module **110**, the body control module **112**, and a vehicle data bus **302**.

The body control module **112** includes a processor or controller **304** and memory **306**. In the illustrated example, the body control module **112** is structured to include door assister **132**. The processor or controller **304** may be any suitable processing device or set of processing devices such as, but not limited to: a microprocessor, a microcontroller-based platform, a suitable integrated circuit, one or more field programmable gate arrays (FPGAs), and/or one or more application-specific integrated circuits (ASICs). The memory **306** may be volatile memory (e.g., RAM, which can include non-volatile RAM, magnetic RAM, ferroelectric RAM, and any other suitable forms); non-volatile memory (e.g., disk memory, FLASH memory, EPROMs, EEPROMs, non-volatile solid-state memory, etc.), unalterable memory (e.g., EPROMs), read-only memory, and/or high-capacity storage devices (e.g., hard drives, solid state drives, etc). In some examples, the memory **306** includes multiple kinds of memory, particularly volatile memory and non-volatile memory.

The memory **306** is computer readable media on which one or more sets of instructions, such as the software for operating the methods of the present disclosure can be embedded. The instructions may embody one or more of the methods or logic as described herein. In a particular embodiment, the instructions may reside completely, or at least partially, within any one or more of the memory **306**, the computer readable medium, and/or within the processor **304** during execution of the instructions.

The terms "non-transitory computer-readable medium" and "tangible computer-readable medium" should be understood to include a single medium or multiple media, such as a centralized or distributed database, and/or associated caches and servers that store one or more sets of instructions. The terms "non-transitory computer-readable medium" and "tangible computer-readable medium" also include any tangible medium that is capable of storing, encoding or carrying a set of instructions for execution by a processor or that cause a system to perform any one or more of the methods or operations disclosed herein. As used herein, the term "tangible computer readable medium" is expressly defined to include any type of computer readable storage device and/or storage disk and to exclude propagating signals

The vehicle data bus **302** communicatively couples the restraint control module **104**, the infotainment head unit **106**, the power train control module **108**, the on-board communications module **110**, and the body control module **112**. In some examples, the vehicle data bus **302** includes one or more data buses. The vehicle data bus **302** may be implemented in accordance with a controller area network (CAN) bus protocol as defined by International Standards Organization (ISO) 11898-1, a Media Oriented Systems Transport (MOST) bus protocol, a CAN flexible data (CAN-FD) bus protocol (ISO 11898-7) and/a K-line bus protocol (ISO 9141 and ISO 14230-1), and/or an Ethernet™ bus protocol IEEE 802.3 (2002 onwards), etc.

FIG. **4** is a flowchart of a method to apply a door adjustment force to a door of the vehicle **100** of FIG. **1**, which may be implemented by the electronic components **300** of FIG. **3**. The door assister **132** beings the method of FIG. **3** when the vehicle **100** is stopped, as communicated by the power train control module **108**. Initially, at block **402**, the door assister **132** determines the roll and pitch angles of the vehicle **100** via the restraint control module **104**. At block **404**, the door assister **132** determines environmental factors proximate the vehicle **100**. For example, the door assister **132** may determine the wind velocity via the on-board communications module **110** and determine the orientation of the vehicle **100** via the restraint control module **104**. At block **406**, the door assister **132** monitors the movement of the doors via the door position sensors **114**. At block **408**, the door assister **132** determines whether door movement was detected. When door movement is detected, the method continues to block **410**. Otherwise, then door movement is not detected, the method returns to block **402**.

At block **410**, the door assister **132** determines which door is moving. At block **412**, the door assister **132** classifies the door movement. To classify the door movement, the door assister **132** determines (a) whether the door is opening or closing and (b) the directions of the gravitational force on the door being moved accounting for (i) the pitch and roll angles of the vehicle **100** and (ii) the relative position of the door to the pitch and roll angles. At block **414**, the door assister **132** determines whether a profile and/or settings is/are associated with the moving door. When a profile and/or settings is/are associated with the moving door, the method continues to block **416**. Otherwise, when a profile and/or settings is/are not associated with the moving door, the method continues to block **418**. At block **416**, the door assister **132** determines the door adjustment force based on the roll and pitch angles of the vehicle **100**, the environmental factors, the door movement classification, and the profile/settings information.

At block **418**, the door assister **132** determines whether the occupant associated with the moving door is struggling to open or close the door. When the occupant associated with the moving door is struggling, the method continues at block **420**. Otherwise, when the occupant associated with the moving door is not struggling, the method continues at block **422**. At block **420**, the door assister **132** determines the door adjustment force based on the roll and pitch angles of the vehicle **100**, the environmental factors, the door movement classification, and a struggle factor. At block **422**, the door assister **132** determines the door adjustment force based on the roll and pitch angles of the vehicle **100**, the environmental factors, the door movement classification. At block **424**, the door assister **132** applies the door adjustment force to the moving door via the door assist module **116**.

FIG. **5** is a flowchart of a method to apply an emergency force to the door of the vehicle of FIG. **1**, which may be implemented by the electronic components of FIG. **3**. Initially, the door assister **132** waits until the on-board communications module **110** activates emergency assist (block **502**) or the emergency switch **128** is pressed (block **504**). At block **506**, the door assister **132** illuminates the lighting element **130**. At block **508**, the door assister **132** determines whether it has received confirmation of an emergency. In some examples, the confirmation may be received via an interface on the infotainment head unit **106**. Alternatively or additionally, in some examples, the confirmation is received from a transponder operated by an emergency responder via the on-board communications module **110**. At block **510**, when the confirmation is received or the emergency switch **128** is activated, the door assister **132** waits until the vehicle **100** is stopped. At block **512**, when the vehicle **100** is stopped, the door assister **132** prepares the doors of the vehicle **100** to be opened. For example, the door assister **132** may cause the lock control **126** to unlock and unlatch the doors. At block **514**, the door assister **132** waits until the interior or exterior handle of the vehicle **100** is pulled. At block **516**, when the interior or exterior handle of the vehicle **100** is pulled, the door assister **132** applies the emergency force to the door via the door assist module **116**.

The flowcharts of FIGS. **4** and **5** are representative of machine readable instructions stored in memory (such as the memory **306** of FIG. **3**) that comprise one or more programs that, when executed by a processor (such as the processor **304** of FIG. **3**), cause the vehicle **100** to implement the example door assister **132** of FIGS. **1** and **3**. Further, although the example program(s) is/are described with reference to the flowcharts illustrated in FIGS. **4** and **5**, many other methods of implementing the example door assister **132** may alternatively be used. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, or combined.

The above-described embodiments, and particularly any "preferred" embodiments, are possible examples of implementations and merely set forth for a clear understanding of the principles of the invention. Many variations and modifications may be made to the above-described embodiment(s) without substantially departing from the spirit and principles of the techniques described herein. All modifications are intended to be included herein within the scope of this disclosure and protected by the following claims. As used here, the terms "module" and "unit" refer to hardware with circuitry to provide communication, control and/or monitoring capabilities, often in conjunction with sensors. "Modules" and "units" may also include firmware that executes on the circuitry. The terms "includes," "including," and "include" are inclusive and have the same scope as "comprises," "comprising," and "comprise" respectively.

What is claimed is:

1. A vehicle comprising:

a solenoid between a frame of the vehicle and a door;

a restraint control module with an accelerometer to provide a roll angle and a pitch angle of the vehicle; and

a body control module including a processor to:

determine one or more physical attributes of an occupant of the vehicle based on a profile of the occupant;

determine a door adjustment force based on at least one of the roll angle, the pitch angle, or the one or more physical attributes of the occupant; and

when the door is moving, apply the door adjustment force with the solenoid.

2. The vehicle of claim **1**, wherein the body control module is to identify the door that is moving.

3. The vehicle of claim **1** including an emergency switch recessed into a body of the door, and wherein the body control module is to enter an emergency mode in response to activation of the emergency switch.

4. The vehicle of claim **3**, wherein in the emergency mode, the body control module is to:

unlock and unlatch the door; and

in response to an activation of at least one of an internal handle or an external handle, apply an emergency force to the door via the solenoid.

5. The vehicle of claim **1**, including an on-board communications platform, and wherein the body control module is to enter an emergency mode in response to the on-board communications platform activating emergency assist and receiving confirmation that an accident occurred.

6. The vehicle of claim **5**, wherein in the emergency mode, the body control module is to, in response to an activation of at least one of an internal handle or an external handle, apply an emergency force to the door via the solenoid.

7. The vehicle of claim **5**, wherein the body control module is to receive the confirmation from at least one of the occupant via an interface in the vehicle or an emergency responder from a transponder outside the vehicle.

8. A method comprising:

determining, via a restrain control module, at least one of a pitch angle and a roll angle of a vehicle;

retrieving information from a profile of an occupant of the vehicle, the profile comprising one or more physical attributes of the occupant;

determining, with a processor, a door adjustment force based on at least one of the roll angle, the pitch angle, or the one or more physical attributes of the occupant; and

applying the door adjustment force with a solenoid positioned between a frame of the vehicle and a door of the vehicle, to assist the occupant move the door.

9. The method of claim **8**, including entering an emergency mode in response to activation of an emergency switch recessed into the door.

10. The method of claim **9**, including, in response to entering the emergency mode:

unlocking and unlatching the door; and

in response to an activation of at least one of an internal handle or an external handle, applying an emergency force to the door via the solenoid.

11. The method of claim **8**, including entering an emergency mode in response to an on-board communications platform activating emergency assist and receiving confirmation that an accident occurred.

12. The method of claim **11**, in response to entering the emergency mode:

unlocking and unlatching the door; and

in response to an activation of at least one of an internal handle or an external handle, apply an emergency force to the door via the solenoid.

13. The method of claim **11**, including receiving the confirmation from at least one of the occupant via an interface in the vehicle or an emergency responder from a transponder outside the vehicle.

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